

A closer look at fracture healing

Citation for published version (APA):

de Jong, J. J. A. (2017). *A closer look at fracture healing: fracture healing at the distal assessed using high-resolution peripheral quantitative computed tomography*. [Doctoral Thesis, Maastricht University]. Maastricht University. <https://doi.org/10.26481/dis.20170113jdj>

Document status and date:

Published: 01/01/2017

DOI:

[10.26481/dis.20170113jdj](https://doi.org/10.26481/dis.20170113jdj)

Document Version:

Publisher's PDF, also known as Version of record

Please check the document version of this publication:

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Valorization

During my research on fracture healing at the distal radius, I have only seen a fraction of all patients that visited the emergency department after they sustained a fracture. Yet, even in this small group of patients I noticed that patients are mostly looking forward to the moment of cast removal. Since I have never fractured a bone in my body, I can only imagine how annoying it must be not being able to scratch where it itches or not being able to wash away the sweat (and smell) on hot summer days. Would it therefore not be great if the time of wearing a cast is kept to a minimum for each individual patient? Besides these benefits on an individual level, reduction of cast immobilization time could also benefit the society by lowering the costs that are indirectly related to distal radius fractures, such as loss of productivity or days of sick-leave.

Since the main purpose of a cast is to provide the necessary stability until the fractured bone has regained sufficient bone strength, the time to cast removal can be reduced by simply speeding up bone strength recovery. However, in order to assess bone strength recovery in the individual patient, a quantitative non-invasive method is required. In this thesis, we mainly focused on exploring the use of a new imaging method because plain radiographs that are currently used to study the fracture healing process lack detailed quantitative information regarding the consolidation of the micro-architecture and neither do they provide quantitative information on the restoration of bone strength.

In 2005, high-resolution peripheral quantitative computed tomography (HRpQCT) was introduced. With a resolution of 82 μm it has the capability to assess the bone's micro-architecture. In addition, 3D models can be created from these high-resolution images which in turn can be used in micro finite element analysis in order to estimate bone strength. Whereas most research on bone quality mainly used these techniques to study bone quality during aging, under healthy and diseased conditions, and following medication, we explored, for the first time ever, the potential of HRpQCT in combination with newly developed imaging analysis techniques to study the fracture healing process. We showed that we can reliably monitor the fracture healing process of distal radius fractures during the first twelve weeks using HRpQCT in terms of bone density, micro-architecture and bone strength parameters, and that changes in these parameters were associated with clinical outcome, such as pain and disability, at the end of this twelve-week period. Also, we developed algorithms that could visualize and quantify the impressive amounts of bone modeling and remodeling during the fracture healing process in high detail.

In order to achieve this, a combined effort of several departments in the different stages of the study was required: starting with providing patient information to eligible patients at the emergency department, to inclusion and short-term follow-up by the orthopaedic surgeon, and finally the long-term follow-up by the endocrinologist. In other words, we have gained valuable experience in how to set up a framework for conducting fracture healing related research in a clinical setting.

Based on the framework and concepts we developed while studying the feasibility of HRpQCT to monitor the fracture healing process for more than 5 years, we believe that Maastricht University Medical Center is currently one of the expert centers in the world for clinical research on fracture healing. That said, it is now feasible to collaborate with pharmaceutical companies in clinical trials to study the effect of their drugs on the fracture healing process. Both safety aspects and probable positive effects regarding fracture healing can now be studied with the algorithms we developed. It would be interesting to invite pharmaceutical companies to participate in studies with existing drugs. In this way, only a minor investment of their side is required. In return, they can potentially use existing drugs for new purposes. Since this does not involve the high costs that are associated with development of new drugs, the risk-benefit ratio for the pharmaceutical companies is rather small. For example, these kind of studies could already be performed with 30 patients (10 controls, 20 on treatment) during six visits that are scheduled within the first year after fracture.

Also for non-pharmaceutical companies working together with the HRpQCT group at the Maastricht University Medical Center might be interesting. For instance, companies that develop medical devices that aim to improve fracture healing, can collaborate with us to study the effect of their device in patients with a fracture in more detail than ever before. These results could then be used to optimize the design, leading to a more effective medical device.

Such collaborations with industry are also beneficial for Maastricht University and its research schools. First of all, with these funds a new PhD-student can be appointed. Furthermore, pharmaceutical and medical device companies are often operating world-wide. Collaborating with such an international partner would add to the international allure that Maastricht University envisions.

In the end, however, these developments, i.e. new drugs or medical devices that aim to improve the fracture healing outcome, should result in shorter healing times, better functional recovery and less pain in patients with a fracture.